# Executive Summary

## Project Background

The Southern California Association of Governments (SCAG) is planning the development of the future transportation system for the Los Angeles Basin. Community Link 21, the Regional Transportation Plan (RTP) adopted by the Regional Council in April 1998, provides a transportation vision to year 2020 along with a framework for future transportation improvement projects. The RTP is a comprehensive plan to achieve mobility, air quality, and other regional goals in the six-county Southern California region (Ventura, Los Angeles, Orange, San Bernardino, Riverside and Imperial counties). Implementing the elements of this landmark RTP will allow the region to meet the stated mobility goals and demonstrate air quality conformity in a financially constrained environment.

A significant component of the RTP is the provision of sufficient capacity to handle regional airport demand. Southern California is a global crossroad between America, Asia and Europe. A great deal of the economic success of the region is attributable to capitalizing on this. In the future, without expansion, regional airport demand is expected to outpace capacity by a significant margin. By 2020, the passenger capacity shortfall is expected to be one-third of the demand. This is further emphasized by the fact that air cargo is expected to have a capacity shortfall of approximately two-thirds. A likely outcome is a significant loss of economic benefits for the region. The challenge for SCAG, Los Angeles World Airports (LAWA) and the region will be in finding a way to keep pace with air demand to capture the full potential economic benefits of air commerce.

Accommodating the growth in air passenger and air cargo demand will require a multi-faceted approach of judiciously accommodating demand for commercial airports and converting available military bases. SCAG and LAWA are cognizant that the potential adverse impacts of airport expansion require the development of regional strategies and policies to maximize passenger and cargo utilization of outlying airports in less populated areas. The task is to develop policies that promote outlying airport growth while reducing regional trip making and community impacts. As brought forward in the RTP, a potential solution towards meeting this challenge is the use of high-speed links to connect the airports.

The Southern California Maglev Deployment Project was initiated as a call to action and reflected in the 1998 Regional Transportation Plan through provisions for a high-speed network. On June 30, 2000, SCAG completed a pre-deployment assessment of a maglev corridor between Los Angeles International Airport (LAX) and March Inland Port (the former March Air Force Base) as part of the Federal Railroad Administration (FRA) competition for maglev deployment in the United States. Due to the complexity of the system, the SCAG proposal was not down-selected by the FRA. The FRA wanted a smaller, more easily implementable system as a demonstration project. But the study confirmed the tremendous benefit and need and the ability of the region to implement such a system. SCAG was encouraged by the FRA to continue deployment studies with the allocation of additional federal maglev study funds. The LAX-PMD high-speed ground access study is a continuance of the SCAG high-speed intraregional network investigation.

## The Current Study

The main objective of the Los Angeles International Airport (LAX) to Palmdale Regional Airport (PMD) high-speed ground access study is to analyze the feasibility of service providing high-speed connectivity along a second corridor between Los Angeles International Airport (LAX), Van Nuys Airport (VNY) and Palmdale Regional Airport (PMD), with a possible connection to Los Angeles Union Station Passenger Terminal (LAUPT). The Project study area is illustrated in Exhibit 1. The study evaluates the following:

- Airport access/interconnection impacts;
- Potential feasible alignments;
- Technology options;
- Investment quality travel demand analysis;
- Conceptual engineering and design;
- Environmental analysis;
- Capital and operations & maintenance (O&M) costs; and
- Financial, operational and implementation plans.

The goal of the study is to identify the potential benefits and examine the impacts of linking the airports as a strategy to balance and distribute future regional airport demand. The study examines a number of system alternatives and makes a recommendation as to the preferred short list of three alternatives for further study. The project culminates with a project pre-deployment plan. Exhibit 2 outlines the overall approach to the study.

Exhibit 1
**STUDY AREA MAP**

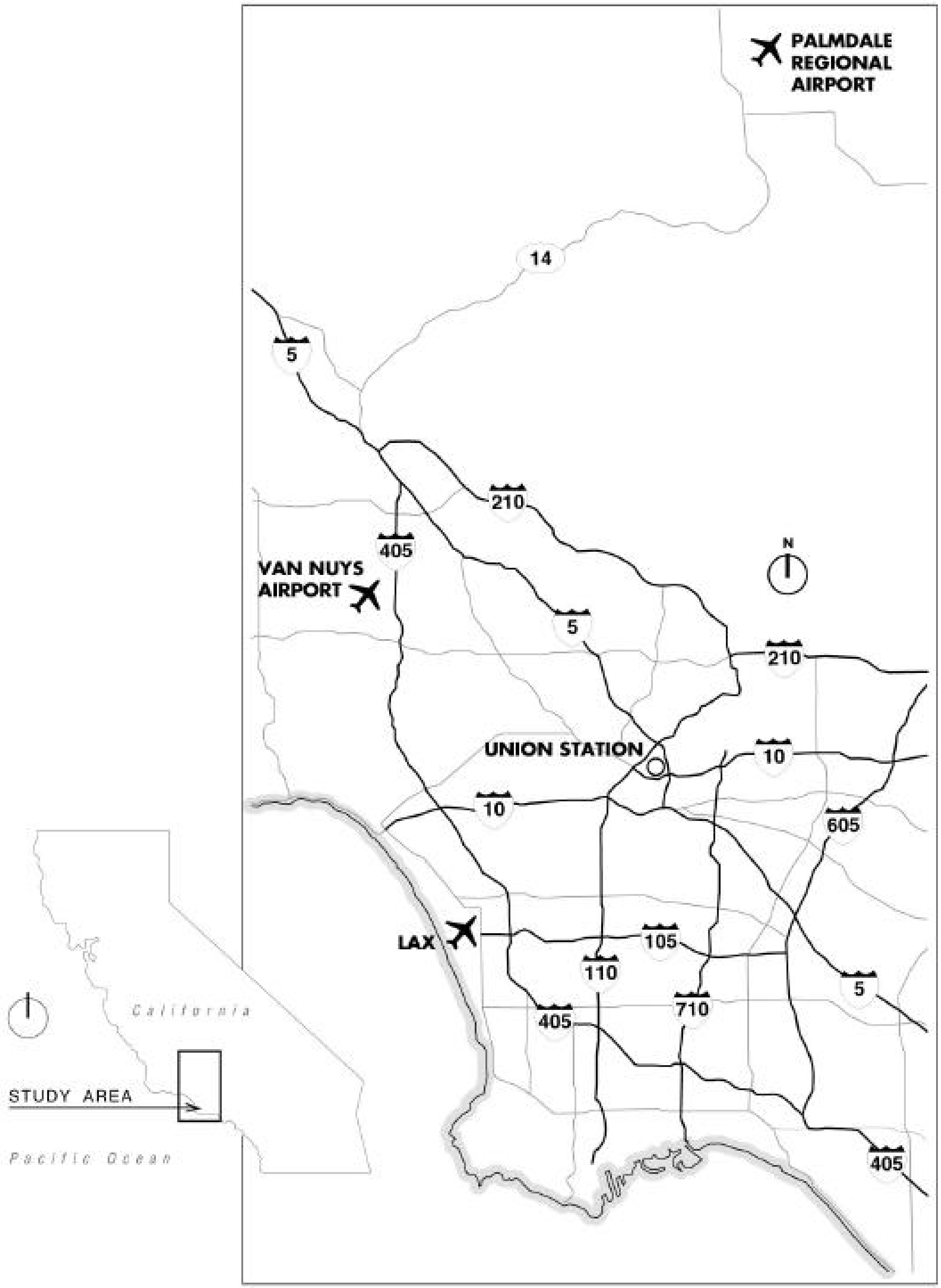
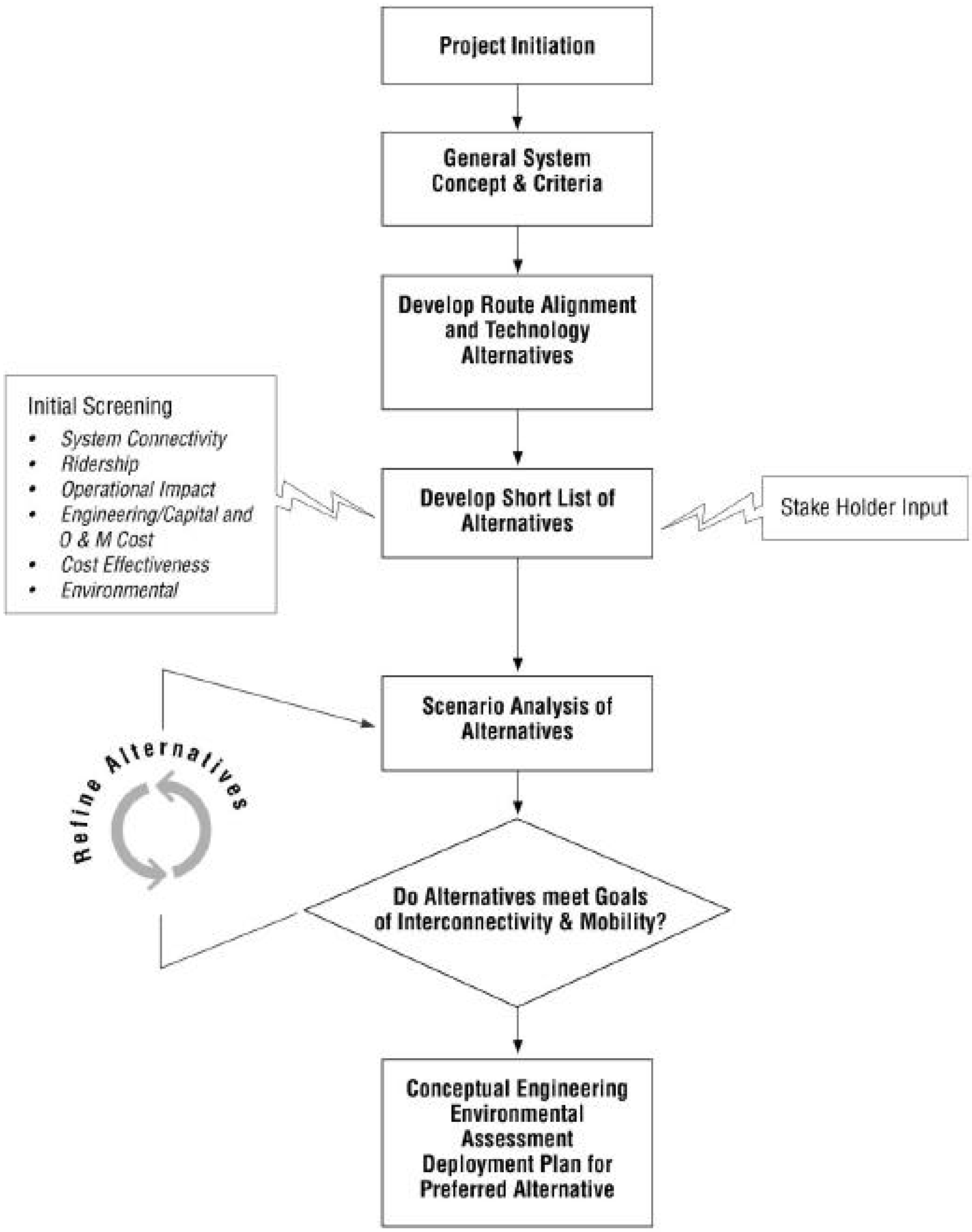


Exhibit 2

**STUDY APPROACH**



### Study Milestones

The LAX-PMD High-Speed Ground Access Study has eleven major tasks, accomplished over an 18-month period. Exhibit 3 presents these tasks, which are outlined below:

***Milestone 1 Project Management Plan*** initiates the project by establishing management and administrative controls, and by developing a strategy plan to effectively coordinate with agencies, advisory groups and the public, and ensuring all federal processes and requirements are satisfied.

***Milestone 2 General System Concepts & Criteria*** set the focus of the technical work in all subsequent efforts. In this milestone the study addresses key issues, including system requirements and goals, and identify major opportunities and constraints. This task helps to narrow the list of potential technology solutions and alignment possibilities.

***Milestone 3 Route Alignment & Technology Alternatives*** defines the vehicle technology options, their relationships to surface, subsurface, and elevated alignments and identifies three finalist route alignment alternatives. The three alternatives are more closely examined and defined in subsequent Milestone efforts including development of an initial operations plan and an order of magnitude cost.

***Milestone 4 Station Locations, Right-of-Way & Urban Design*** develops station location criteria and establishes typical design guidelines that address such items as access areas, station signage, lighting, pedestrian amenities and landscaping, ADA requirements, and platform positioning. Land use strategies and urban design recommendations are made for improving the effectiveness of the system by encouraging station area development.

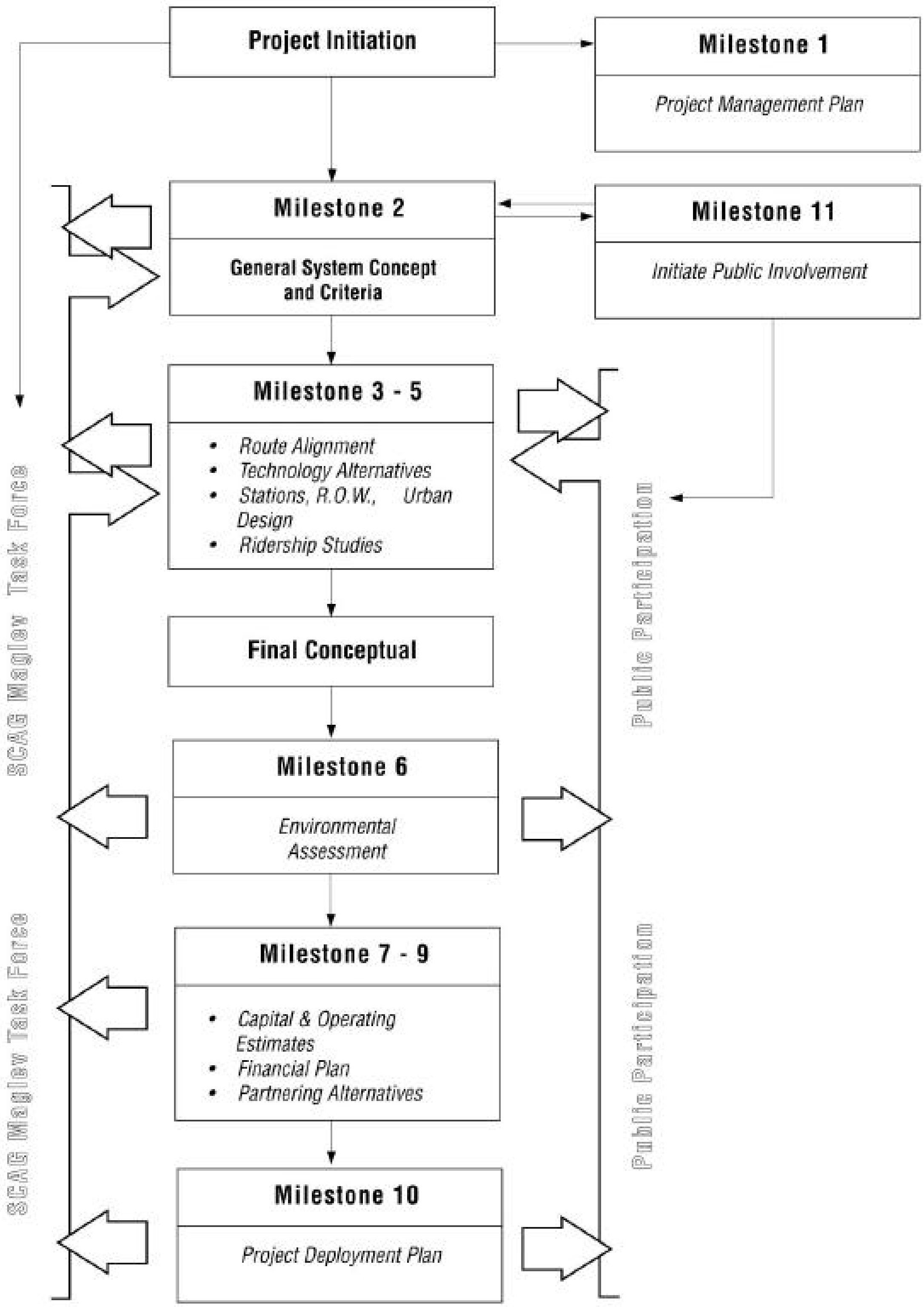
***Milestone 5 Ridership Studies & Analysis*** develops ridership and revenue forecasts at a level of detail sufficient to meet investment quality criteria necessary to support financial assumptions, identify environmental impacts and quantify benefits. A similar methodology, forecasting assumptions, models and approach was used in the LAX to March Maglev Project.

***Milestone 6 Environmental Assessment*** provides an overall assessment of environmental issues and potential impacts related to the implementation of high-speed technology options between Los Angeles International Airport, Van Nuys, and Palmdale Airport. The assessment can serve as a basis for subsequent comprehensive environmental documents that would address construction-level impacts and associated mitigation measures, consistent with the requirements of the National Environmental Protection Act (NEPA) and the California Environmental Quality Act (CEQA).

***Milestone 7 Capital & Operating Cost Estimates*** provides the capital and operating cost estimates for the proposed high-speed line. Cost estimates are based on project design at an appropriate planning level.

***Milestone 8 Financial Plan*** prepares a financial plan that is structured around funding sources, financing mechanisms and institutional arrangements. Order of magnitude financing requirements for implementation and operation are developed along with a federal funding strategy, identification of private investment and innovative financing opportunities.

Exhibit 3
**MILESTONE PROCESS**



***Milestone 9 Partnering Alternatives Plan*** develops a strategy for creating an optimal relationship between public and private sectors. The partnering strategy is developed in a three-step process. The first involves identifying the requirements and criteria for successful partnering arrangements. The second step develops the alternative partnering models. And the final step involves assessing the alternatives in light of the requirements and criteria in consultation with key stakeholders.

***Milestone 10 Project Pre-Deployment Plan*** recommends the most appropriate combined alignments, technology, and implementation structure for the LAX-PMD high-speed ground access system, and provides a strategy for follow-up. The Milestone 10 report serves as a "final report" and project summary for the LAX-PMD analysis.

***Milestone 11 Public Involvement Plan*** is the summary of the comprehensive outreach program initiated for the LAX-PMD line of the SCAG high-speed intra-regional system. The outreach effort includes targeted and proactive contact with project stakeholders, including key opinion leaders such as public officials, subregional Councils of Government (COGs), community groups and influential business organizations, as well as outreach on a more technical level to public agencies and local cities.

All eleven Milestones were completed, approved and adopted as of December 21, 2001. Copies of the reports, conclusion and findings are available through SCAG.

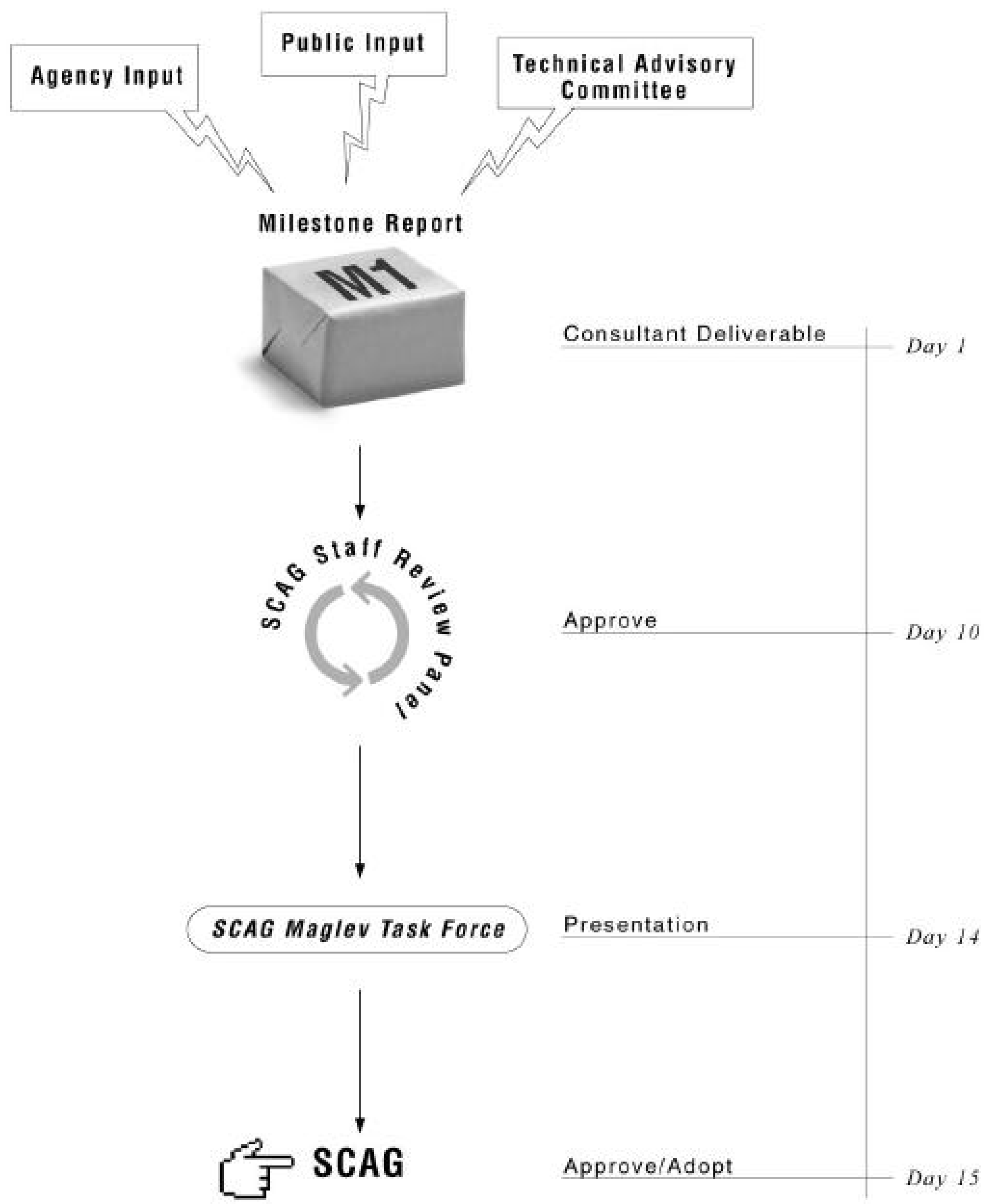
### Project Decision-Making Organizational Structure

The milestones constitute key decision points during the project process. The milestone process provides an effective tool in moving a project forward. When completed and approved, the milestone reports demonstrate that study goals and objectives have been met and further development and analyses can be made based on the foundation of the approved and adopted results.

As detailed in Exhibit 4, an expedited decision-making structure was adopted by SCAG in order to meet the 18-month schedule. The process provides a three-week period for Milestone report review, comment, presentation, approval and adoption. Once adopted, Milestones are finalized and submitted to SCAG.

**Exhibit 4**

**PROJECT DECISION-MAKING PROCESS**



### Study Process

The LAX-PMD High Speed Ground Access System study effort began with three general system configurations. These configurations were:

1. ***Base:*** *Palmdale-Santa Clarita-Van Nuys-West Los Angeles-Los Angeles International Airport (LAX).*

2. ***"S" Configuration****: Palmdale-Santa Clarita-Van Nuys (option)-Union Station-West LA (option)-LAX.*

3. ***Tunnel****: Palmdale-Union Station-LAX. Through San Gabriel Mountains.*

The tunnel configuration was eliminated due to high potential costs and low ridership potential, since it misses Santa Clarita and the San Fernando Valley.

A series of alignment alternatives was defined and analyzed using basic technical criteria (length, travel time, ridership potential, relative costs, environmental fatal flaws, etc.) to produce a short list of alignment segments between LAX and PMD. These were combined into the three final project alternatives that were the focus of this study.

### Project Alternatives

The LAX-PMD High Speed Ground Access System will be a system that will serve as an airport and urban center connector while reducing automobile congestion in the Southern California region. The Project Study Team has evaluated multiple route alignments, station locations, service technologies, and system operations to develop three short-listed potential alignments, ten potential stations serving the various alignments, and recommended technologies. The three recommended short-list alternative routes are:

1. ***Airport Connector*** - Alternative 1 (Metrolink Antelope Valley Line, Golden State I-5 Freeway, and San Diego I-405 Freeway) is the fastest combination between LAX and PMD and best serves the airport connector role. The length of this alternative is 116 kilometers (72 miles). The initial estimate of the end-to-end travel time is 42 minutes. This is comparable to the desired 60-minute terminal-to-terminal connection time for air passengers, discussed in Milestone 2. The other two alternatives focus more on greater coverage of the study area and therefore have higher travel times.

2. ***Transit Hubs*** - Alternative 2 (Antelope Valley SR-14 Freeway, Metrolink Antelope Valley Line, and Santa Monica I-10 Freeway) includes the other short-listed alternatives, and is a compromise between the congestion relief and airport connector roles. This alternative is 153 kilometers (95 miles) in length, and has an estimated end-to-end travel time of 60 minutes.

3. ***Maximum Coverage*** - Alternative 3 (Antelope Valley SR-14 Freeway, Metrolink Antelope Valley Line, Golden State I-5 Freeway, Metrolink Ventura Line, and Santa Monica I-10 Freeway) achieves maximum penetration into the areas being served and therefore supports the role of congestion relief. The length of this alternative is estimated at 171 kilometers (106 miles), including the portion from Union Station to

LAX that may be part of the California Maglev Project[1]. The initial travel time estimate is 70 minutes from end to end.

The three alternative alignments are displayed in Exhibits 6 through 8 on the following pages.

### Technology Selection

Three technologies were selected as finalists for consideration as the recommended technology for the LAX-PMD High-Speed Ground Access System, high-speed rail (HSR), very high-speed rail (VHSR), and very high-speed maglev (VHSM). Identification of the preferred technology was determined using a set of well-defined criteria established in conjunction with the Federal Transit Administration (FTA), Federal Railroad Administration (FRA) and Southern California Association of Governments (SCAG) goals. The categories are:

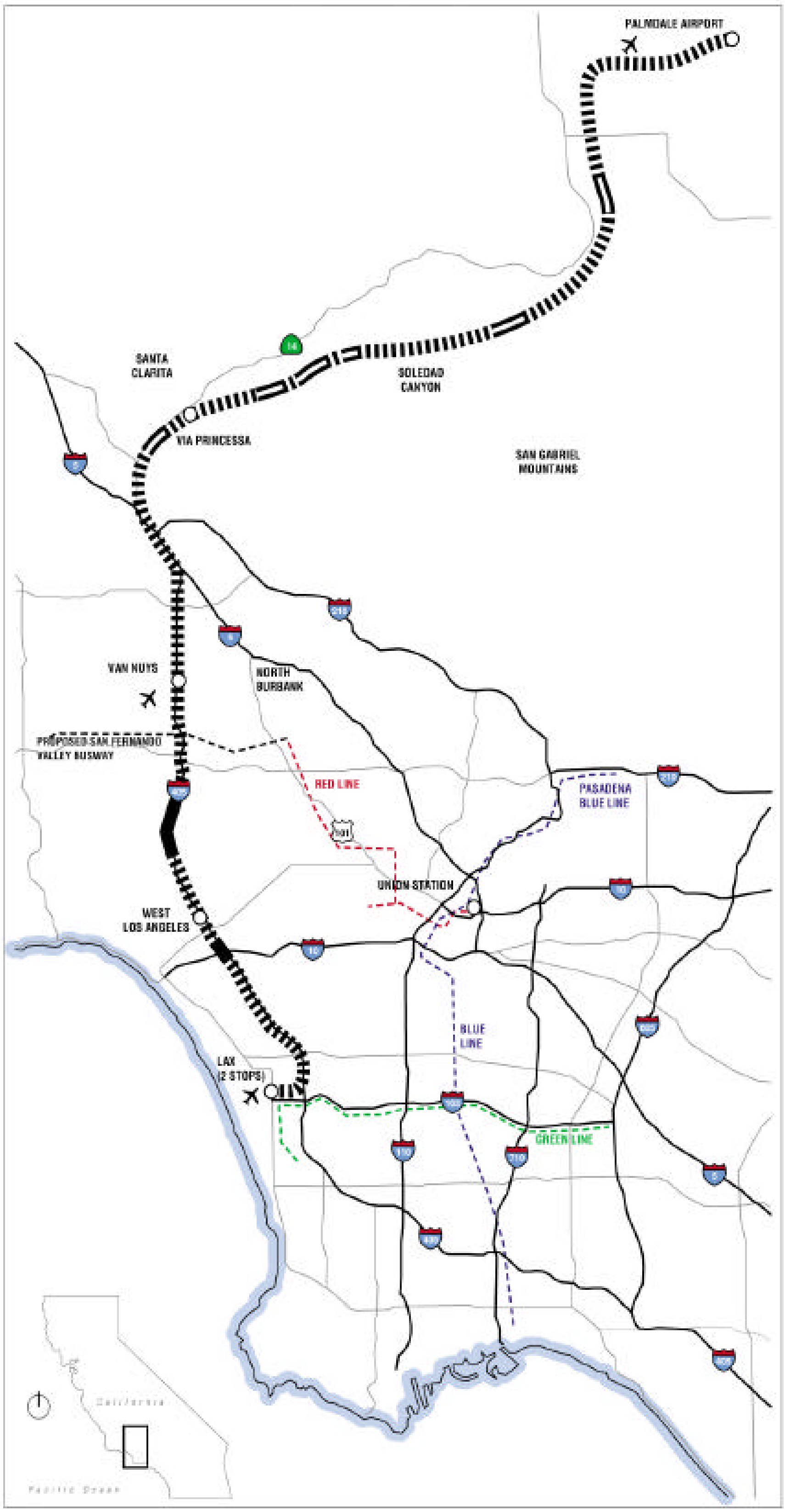
- Operations - maximum speed, average running speeds, geometrical constraints, and right-of-way impacts
- Service Levels - travel times, reliability, capacity, frequency and convenience of service, and rider comfort
- Risks - technological maturity and proven operations/costs
- Safety - potential for at-grade conflicts, the potential for derailment, FRA crash energy management requirements, and barrier requirements
- Energy - energy consumption and efficiency and petroleum reliance
- Environmental Impacts - noise, vibration, and visual impacts
- Ridership/Revenue - image and estimated daily boardings
- Facilities - stations and maintenance yards
- Costs - capital costs, annual operation and maintenance costs, and 20-year lifecycle costs

Each of the potential system technologies was evaluated using the above criteria. The VHSM technology was selected as the preferred alternative based upon the superior performance of the technology in several categories when compared to HSR and VHSR.

[1] LAX-March Corridor, also studied by SCAG

**Exhibit 5**

**AIRPORT CONNECTOR ALTERNATIVE**




**Length:** *115 Km (72 Mi)*

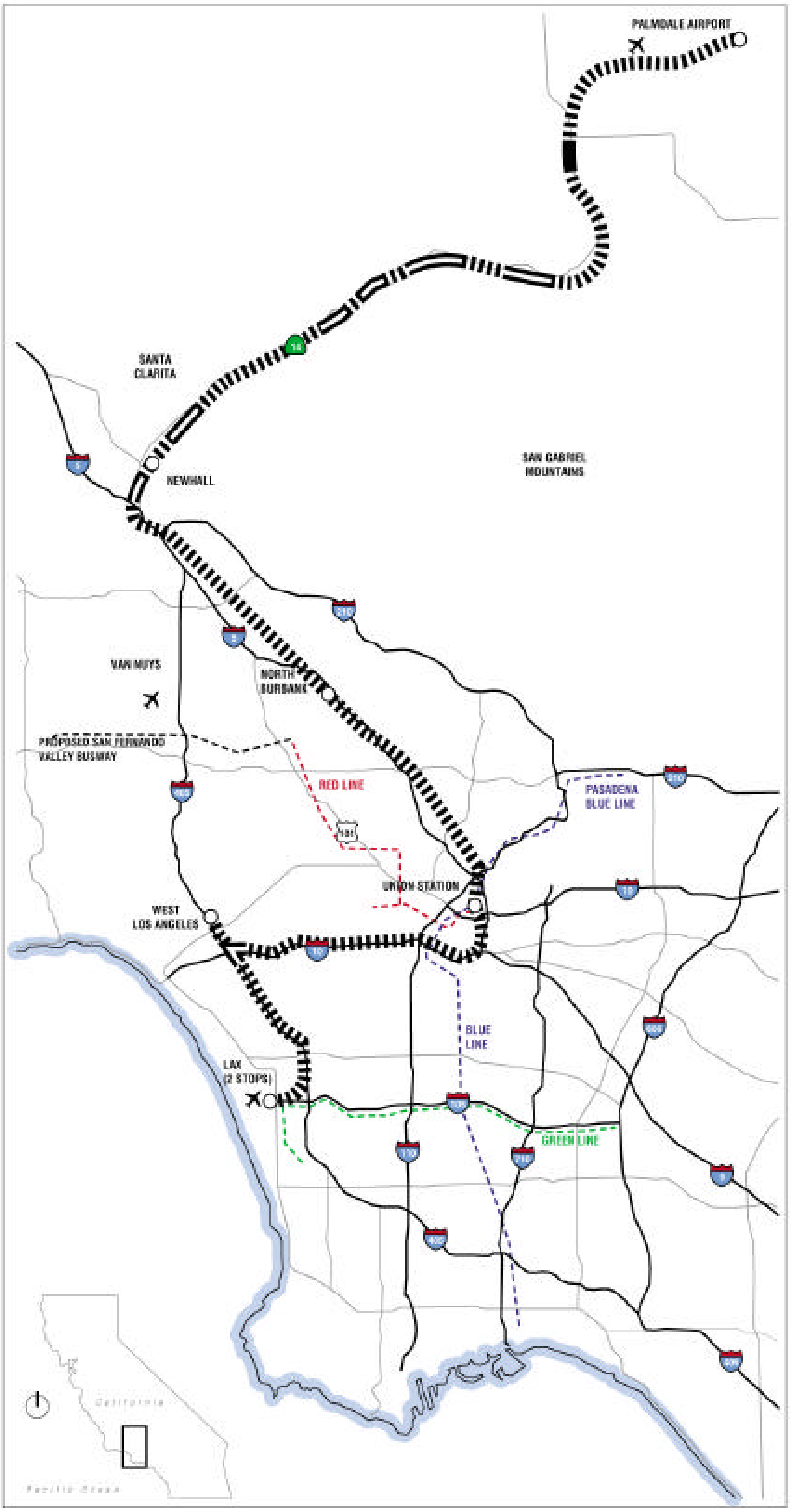
**Maglev Costs** (2000 $):
*Capital: $8.2 billion*
*O&M: $146 million/year*

**High-Speed Costs:**
*Capital: $7.9 billion*
*O&M: $281 million/year*

TUNNEL
CUT/FILL
AERIAL
STATION

**Exhibit 6**

**TRANSIT HUBS ALTERNATIVE**




**Length:** *153 Km (95 Mi)*

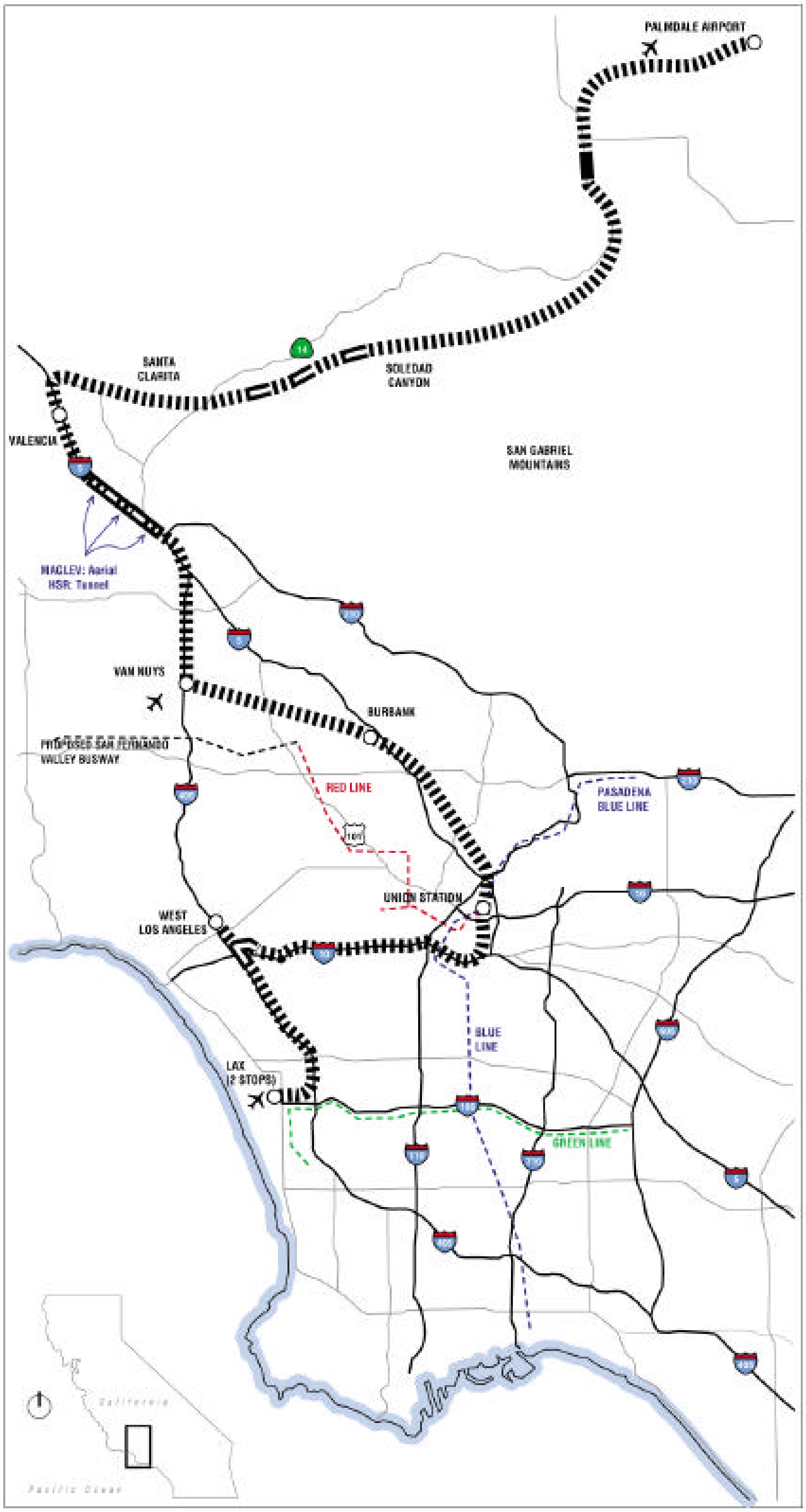
**Maglev Costs** (2000 $):
*Capital: $10.7 billion*
*O&M: $188 million/year*

**High-Speed Costs:**
*Capital: $10.2 billion*
*O&M: $355 million/year*

TUNNEL
CUT/FILL
AERIAL
STATION

**Exhibit 7**

## MAXIMUM COVERAGE ALTERNATIVE




**Length:** *171 Km (106 Mi)*

**Maglev Costs** (2000 $):
*Capital: $11.9 billion*
*O&M: $212 million/year*

**High-Speed Costs:**
*Capital: $11.7 billion*
*O&M: $418 million/year*

TUNNEL
CUT/FILL
AERIAL
STATION

### System Configuration

Using the preferred maglev technology, the operational characteristics of the system were developed. These characteristics were applied to each alternative to determine travel time and passenger load capabilities.

### Operational Parameters

The following parameters, combined with the alignment data, influence train speed:

- Station Dwell – set at 2 minutes.
- Superelevation curves (banking) – limited to 12%.[2] Superelevation is a function of curve radius and will restrict the speed of a train before the curve, require slower speeds throughout the curve, and then allow acceleration coming out of the curve.
- The acceleration, braking and lateral acceleration limits – set at 3.22f/s$^2$ (0.1G). This value allows passengers to freely stand and walk about the cabin, rather than remain seated, during acceleration and braking. Higher acceleration levels would require passengers to remain seated when the train is either accelerating or decelerating.
- 10% grade climbing ability – allowed with minimal speed loss

### Travel Time Parameters

- Total Operating Hours/Day – 18 Hours
- Total Peak Operating Hours/Day – 8 Hours
- Total Off-peak Operating Hours/Day – 10 Hours
- Headways, Peak and Off-Peak – 10 Minutes
- Turnaround time – There is a 30-minute layover at the end of every round trip. This time is not included in the one-way trip time calculations.

### Fleet Characteristics

Each 502-ft. long maglev train will consist of six vehicles coupled semi-permanently and will carry 600 passengers. The proposed system (and corresponding platform lengths) would couple two six-car consists for commuter operations during the morning and afternoon rush hours periods. The two types of vehicles are power cars and passenger cars.

The fleet sizes were estimated based on the round-trip time for each alignment alternative, the 10-minute service headway, the peak passenger load, and the capacity of either the standard six-car trainset or a twelve-car trainset. Spare vehicles are estimated at 20% of the peak load carrying capacity. The simulations used twelve-car trainsets (4

[2] TRI recommends 12% in normal operations.

power cars and 8 passenger cars) for peak service and six-car trainsets (2 power cars and 4 passenger cars for off-peak service. Peak service needs are used to define fleet size.

## Alignment Alternative Characteristics

The following summaries describe the characteristics of the three proposed alignment alternatives. These characteristics include station locations, travel time, ridership, and estimated revenues.

### *Airport Connector Alternative*

Five stations are located along the 115 km (72 mi) route:

- LAX Commuter Platform (I-405/Arbor Vitae)/LAX Terminal (near Terminal 1)
- West Los Angeles (I-405/Wilshire Boulevard)
- Van Nuys (I-405/Roscoe Boulevard)
- Santa Clarita East (SR-14/Via Princessa)
- Palmdale Airport (future terminal)

Travel Time – 42 minutes, average, one-way

Fleet Size – 12 twelve-car train sets are needed at peak.

Weekday Daily Ridership – 102,500 passengers

Annual Ridership – 30,000,000 passengers

Total System Annual Revenues – $417 million (in 2000 dollars)

### *Transit Hubs Alternative*

This alternative is approximately 153 km (95 mi) in length and features six stations:

- LAX East Terminal Complex (near Terminal 1) and LAX Commuter Platform (I-405/Arbor Vitae);
- West Los Angeles (I-405, at Wilshire Boulevard);
- Los Angeles (L.A.) Union Station;
- Burbank (Metrolink corridor, near Hollywood Way);
- Santa Clarita East (SR-14 / San Fernando Road);
- Palmdale Airport (future terminal).

Travel Time – 60 minutes, average, one-way

Fleet Size – 15 twelve-car train sets are needed at peak.

Weekday Daily Ridership – 141,500 passengers

Annual Ridership – 41,500,000 passengers

Total System Annual Revenues – $580 million (in 2000 dollars)

***Maximum Coverage Alternative***

This alternative is 171 km (106 mi) in length and features seven stations:

- LAX East Terminal Complex (near Terminal 1) and LAX Commuter Platform (I-405/Arbor Vitae);
- West Los Angeles (I-405, at Wilshire Boulevard);
- Los Angeles (L.A.) Union Station;
- Burbank (Ventura Metrolink corridor, at I-5 near Olive Avenue);
- Van Nuys (I-405 near Roscoe Boulevard, north of Metrolink);
- Santa Clarita – Valencia (I-5 between Valencia and Magic Mountain Parkway);
- Palmdale Airport (future terminal).

Travel Time – 70 minutes, average, one-way

Fleet Size – 17 twelve-car train sets are needed at peak. The peak service fleet consists of 68 power cars and 136 passenger cars. Application of the 20% spare ratio typically used to size rail fleets, the overall fleet size is 82 power cars and 164 passenger cars.

Weekday Daily Ridership – 153,000 passengers

Annual Ridership – 45,000,000 passengers

### Project Costs and Finances

Comparison of the capital and operating and maintenance costs for the alternative technologies and alignments indicate that while the VHSM technology has a higher initial capital cost, the lower annual operation and maintenance costs are due in large part to a smaller vehicle fleet requirement expected to quickly offset this disadvantage.

Capital costs were developed assuming the entire alignment is dual-lane guideway and the fleet is sized to support 10-minute headways during the peak period. Table 1 lists the estimated capital costs for High Speed Rail/Very High Speed Rail (HSR/VHSR) and Very High Speed Maglev (VHSM) technologies for each of the proposed alignments. Costs are planning-level estimates expressed in 2000 dollars and reflect a 5% level of conceptual engineering.

The seven major elements of the capital cost estimate are:

- Structures, Foundations and Tunnels
- Earthwork
- Stations and Maintenance Facilities

- Guideway, Power and Communications
- Maglev Vehicles
- Right-of-Way and Utilities
- Contingencies, Project Implementation and Environmental Mitigation

**Table 1**
**LAX-PMD Capital Cost Estimates**

| Technology | Airport Connector | Transit Hubs | Maximum Coverage |
|---|---|---|---|
| VHSM Standalone | $8.2 Billion | $10.7 Billion | $11.9 Billion |
| HSR/VHSR (for comparison) | $ 7.9 Billion | $10.2 Billion | $11.7 Billion |

Table 2 lists the estimated annual operations and maintenance costs for High Speed Rail/Very High Speed Rain (HSR/VHSR) and Very High Speed Maglev (VHSM) for each of the proposed alignments.

The five principal operating and maintenance cost categories include:

- Maintenance-of-Way (MOW) operations include the activities necessary to keep the guideway and related infrastructure in good operating order.
- Maintenance-of-Equipment (MOE) operations include both the activities necessary to keep the vehicle in good operating order and both exterior and interior cleaning.
- Transportation Operations refers to the costs of actually moving the trains carrying passengers.
- Passenger and Station services are a major portion of total O&M costs.
- General and Administration annual expenses, which cannot be readily assign to other subsections.

**Table 2**
**LAX-PMD Annual Operations & Maintenance Cost Estimates**

| Technology | Airport Connector | Transit Hubs | Maximum Coverage |
|---|---|---|---|
| VHSM Standalone | $ 184 Million | $ 236 Million | $ 267 Million |
| HSR/VHSR (for comparison) | $ 281 Million | $ 355 Million | $ 418 Million |

A multi-year cash flow model was developed, where the three alignments utilized short-term borrowing to fund planning and engineering costs, allocated Federal Transportation Infrastructure Finance & Innovation Act (TIFIA) funds and tax-exempt financing to fund the construction, vehicle purchase and other capital-related costs. The analysis did not incorporate Federal Transit Administration (FTA) New Starts funding, or any State and

Local contributions. In order to assess the magnitude of the borrowing requirements, the analysis considered the length of time required to pay down the capitalized interest and principal requirements. This is the major feature of the project, and makes it difficult to finance. Specifically, revenue operations do not start until 2009, and the project builds on borrowing requirements through substantial capitalized interest accruals.

Due to the high amounts of borrowing required to construct the system, it may be difficult to secure private financing sources. Another factor limiting the potential for private funding is the extended time frame (minimum eight years) until revenue operations begin. Many private sources of financing will desire operating revenue return prior to the projected time frame.

It is highly probable that two factors would improve the financial outlook of the project even further. First, there are potential "savings" to the project if costs for the segment in common with the LAX-March project can be "shared". With the LAX-PMD project itself, there are opportunities to select a shorter initial segment, allowing revenue operations to begin earlier and offset the initial capital investment (and interest) on the construction of the shorter segment.

### Next Steps

The next steps for SCAG in development of this project are:

- Further engineering and environmental study to define the system in greater detail, refine costs and financial calculations, and determine impacts and mitigations for the project.

- Select a preferred alignment, including an initial segment, which would become the focus of study once adopted by SCAG.

- SCAG must also continue the work that has started in public and government outreach. It will be essential to build a consensus between government agencies affected by this project including cities along the route, the County of Los Angeles, Caltrans, and the owners of the railroad rights-of-way. Community and environmental groups must also be included in the project process to ensure the inclusion of all interested parties.

Issues are still present that would impact the selected recommended alternative and its final alignment. Selection of the final alignment will be based on a review of critical issues that have been uncovered in the previous studies and any new issues discovered during the refinement stage. Further definition of these critical issues and mitigating solutions will provide the basis for the preferred alignment alternative.

Once a recommended alignment has been defined for further study, the specific criteria should be used to define smaller segments of the alignment that can potentially be constructed by a private investor as the first phase of the LAX-PMD Maglev system. The criteria include:

- Initial Ridership and Growth Potential
- Initial Capital Costs and Operating Cash Flow Projections

- Constructibility
- Commercial and Residential Development Potential
- Transit Oriented Development Potential
- Connectivity and Station Placement
- Technology Constraints and Readiness
- Environmental Impacts and Constraints

**Deployment Options**

Environmental review of the project will be one of the next major phases in the development of this proposed high-speed rail system. Preliminary engineering is performed in conjunction with the environmental review of the project. The project will require clearance under the Federal Government's National Environmental Policy Act (NEPA) process and the State of California's California Environmental Quality Act (CEQA) process. To fulfill these requirements, SCAG must prepare a joint Environmental Impact Statement (EIS) and Environmental Impact Report (EIR). The EIS/EIR can be prepared to analyze a single recommended alignment or the document can analyze all three proposed alignments in order to support the decision-making process that leads to adoption of a Locally Preferred Alternative (LPA), and help support selection of an initial segment.

There is currently no maglev system in regular revenue service, although, consortia in Japan, Germany, and the United States are pursuing this technology. The German maglev technology is currently being demonstrated by TRI and represents the most advanced system in operation. The German government has granted a Certification of Technical Readiness for the TRI technology. TRI is also building a system in China that is expected to enter revenue service in 2003 or 2004. Although the TRI Maglev technology is highly developed, Japanese systems may become competitive in the timeframes suggested in this investment report.

Due to the limited number of suppliers of this technology and the limited overall implementation expertise, maglev technology should be procured from a single entity, called the Design-Build-Entity (D-B-E) with a Design-Build-Operate-Maintain (DBOM) procurement program. The owner has the option to include some or all of the fixed facilities (guideway, track, stations, and power systems) in the same program as the operating system (vehicles, traction power, train control, and communications). The program could be separated into two or more DBOM programs. For example, the facilities and stations would be familiar to local designers and constructors and could be bid separately from the guideway and operating system as either a DBOM or a traditional Design-Bid-Build program. A balanced procurement strategy can be deployed that utilizes a DBOM program for the maglev technology and possibly the guideway, while more traditional contracting options could be used for the other facilities.